REMARKS

Claims 1-14 are currently pending in this application.

Claims 1-10 have been rejected under 35 U.S.C. § 112, second paragraph for failing to particularly point out and distinctly claim the invention, based on certain formal issues identified by the Examiner in items 4 through 9 of the Office Action. In response to these grounds of rejection, Applicants have amended the claims in a manner which addresses and is believed to resolve each of the cited formal issues. In particular, Claim 1, from which Claims 2 through 9 depend, has been amended to recite a positive step of "controlling the quantity of fuel supplied to the fuel cell system". In addition, the phrase "a predefined desired value" has been changed to "a preset target value". Applicants respectfully submit that a person skilled in the art, and familiar in particular with feedback control systems, will immediately recognize the use of the terms "target" and "actual" values, which constitute parameters for adjusting a control signal in a feedback control system, such as defined in the present application. (See paragraph [0023].)

Also, in response to item 6, the phrase "pause-to-switch-on ratio" has been defined in Claim 1, and Claim 4 has been cancelled. Finally, the phrases "relatively smaller" and "relatively larger" in Claim 9 have been deleted. Accordingly, Applicants respectfully submit that all claims which remain of record in this application are now clear and definite.

Claims 1, 3, 4, 10 and 11 have been rejected under 35 U.S.C. §102(e) as anticipated by Autenrieth et al (European patent document EP 1205341 A2, as reflected in corresponding Published U.S. Patent Application No. 2002/0057006, now issued as U.S. Patent No. 6,646,413). In addition, Claim 2 has been rejected under 35 U.S.C. §103(a) as unpatentable over Autenrieth et al, while Claims 6-9, 12, 13 and 14 have been rejected as unpatentable over Autenrieth et al in view of Higashiyama et al (U.S. Patent No. 6,890,673); Claim 5 has been rejected as unpatentable over Autenrieth et al in view of Merritt et al (U.S. Patent No. 5,366,821), and Claims 6-9 and 12-14 have been rejected under 35 U.S.C. § 103(a) as unpatentable over Autenrieth et al in view of Leboe (Published U.S. Patent Applications No. 2004/0080297). However, for the reasons set forth hereinafter, Applicants respectfully submit that all claims which remain of record in this application distinguish over the cited references, whether considered separately or in combination.

The present invention is directed to a method for controlling the operation of a fuel cell system, and in particular for controlling the supply of fuel to the anode side of a fuel cell system. As is well known to those skilled in the art, the dynamic response of fuel cell systems frequently lags the power demand of the load to which the fuel cell system is connected. For this reason, an energy storage device, such as a battery is commonly connected in parallel with the fuel cell system in order to make up the shortfall of available power output from the

fuel cell system. As is also well known to those skilled in the art, the output capacity of a fuel cell system is directly dependent on the amount of fuel which is currently available in the anode.

One problem with fuel cell systems is that in the face of a sharp increase of demand for power output, damage to the fuel cell can result from an overload condition if no action is taken. Accordingly, one approach to remedying this situation, which is illustrated by Autenrieth et al, is to switch the connection between the fuel cell and the load off and on in order to reduce the overall power output of the fuel cell, until sufficient fuel is available to increase its output to the desired level.

The Autenrieth et al reference is therefore an example of the method defined in the preamble to Claim 1 of the present application. Its operation is described in paragraph [0016] at lines 6 through 13; paragraph [0021] and paragraph [0029]. For example, as described in the specification at paragraph [0021], the fuel cell unit 3 is electrically switched off if the load requirement exceeds the amount of fuel that is currently available to the fuel cell. While the fuel cell unit is switched off, fuel and/or oxygen continues to be supplied at the same rate as before, until a sufficient quantity of fuel and/or oxygen is available for the fuel cell to be able to provide the required electric power. (See paragraph [0029], lines 19-22.) Finally, when the fuel concentration is high enough so that

the fuel cell unit 3 can provide sufficient electric power, the switch 10 is closed causing the fuel cell to be electrically switched on again. (See paragraph [0021].)

One difficulty with this arrangement, however, is that the response of the system is relatively slow. That is, when the demand increases sharply, the amount of "pause" time during which the fuel cell system is switched off, becomes relatively longer than during a steady state operation, and recovers only gradually, as fuel accumulates in the anode due to the incoming fuel flow.

The present invention builds upon the prior art device, such as disclosed in Autenrieth et al, and provides a system with improved dynamic response. For this purpose, as recited in Claim 1, the <u>quantity of fuel</u> which is supplied to the fuel cell system <u>is controlled</u> as a function of the "pause-to-switch-on ratio" of the electric connection between the fuel cell and the load. That is, the ratio between the pause interval (during which the system is disconnected), and the switched on interval (during which it is connected), is used to <u>control the quantity of fuel</u> supplied to the fuel cell in a feedback operation, such that the actual value of the pause-to-switch-on ratio is regulated to conform to a preset target value. In this manner, the connection between the fuel cell and the load is rapidly restored to an optimal on/off relationship. The latter feature of the invention is also recited in Claim 11, which provides a step of "controlling a flow of fuel to said fuel cell system as a function of an open/close ratio of said connection".

This feature of the invention is neither taught nor suggested by the Autenrieth et al reference, which contains no discussion of controlling, regulating or adjusting the rate at which fuel is provided to the fuel cell unit. More particularly, it contains no discussion of controlling the flow of fuel based on the on/off or "pause-to-switch-on ratio of the electric connection", such that the latter is regulated to a preset value. Rather, Autenrieth et al merely provides that, "While the fuel cell unit 3 is switched off, fuel and/or oxygen is continually supplied until a sufficient quantity of fuel and/or oxygen is available for the fuel cell unit 3 to be able to provide the required electric power". (Paragraph [0021], lines 6-10.) Similarly, at paragraph [0029], lines 19-20 Autenrieth et al states only that, "[T]he reformer continues to supply hydrogen causing the pressure to increase again on the anode side. When a desired hydrogen pressure value has been reached, the fuel cell unit 3 can be electrically switched on again." Finally, at paragraph [0030], line 6, Autenrieth et al provides that when the available quantity of fuel drops below a specified first threshold value, "the fuel cell unit is electrically switched off and the battery supplies all require power, while at least the fuel supply to the fuel cell unit 3 continues to be maintained". Beyond these general statements that the fuel supply continues to flow, Autenrieth et al contains no teaching or suggestion regarding the rate of fuel flow in response to the on/off or pause-to-switch-on ratio of the electrical connection between the fuel cell and the load. Accordingly, Applicants respectfully submit that Claims 1 and

11, and therefore all claims of record in this application distinguish over Autenrieth et al.

The features discussed above, which distinguish the present invention of Claims 1 and 11 over Autenrieth et al are also neither taught nor suggested by any of the other references. Higashiyama et al, for example, is cited only as teaching a hydrogen producing apparatus and power generating system which is operated by a flow setting means, such that the average supply flow to a hydrogen generator achieves a desired value.

Similarly, Merritt is cited as teaching a fuel cell with a reactant supply and control system in which the fuel utilization ratio of the reactants is defined as the amount of fuel introduced to the fuel cell per unit time divided by the amount of fuel consumed. It is also cited as teaching optimizing the fuel utilization ratio for limiting reactant to improve fuel cell efficiency.

Finally, Leboe is cited as teaching that the parameter setpoint values within a control scheme may be calculated at discrete intervals and continuously or periodically updated. As noted previously, however, none of these references teaches or suggests controlling the flow rate of fuel into the anode as a function of the on/off or pause-to-switch-on ratio of an electrical connection between the fuel cell and a load, such that the latter is regulated to a present value. Accordingly, Applicants respectfully submit that all claims of record distinguish over the latter references, or any combination thereof with Autenrieth et al.

In light of the foregoing remarks, this application should be in condition for allowance, and early passage of this case to issue is respectfully requested. If there are any questions regarding this amendment or the application in general, a telephone call to the undersigned would be appreciated since this should expedite the prosecution of the application for all concerned.

If necessary to effect a timely response, this paper should be considered as a petition for an Extension of Time sufficient to effect a timely response, and please charge any deficiency in fees or credit any overpayments to Deposit Account No. 05-1323 (Docket #038743.52928US).

Respectfully submitted,

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